Acid

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(Redirected from Acidic)

For alternative meanings see acid (disambiguation).

An **acid** (represented by the generic formula **AH**) is typically a water-soluble, sour-tasting chemical compound. In common usage an acid is a species that, when dissolved in water, gives a solution with a pH of less than 7. In general scientific usage an acid is a molecule or ion that is able to give up a proton (H^+ ion) to a base, or accept an unshared pair of electrons from a base. An acid reacts with a base in a neutralization reaction to form a salt.

Acids and Bases:

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In water the following reaction occurs between an acid (AH) and water, which acts as a base:

$$AH + H_2O \leftrightarrow A^- + H_3O^+$$

The acidity constant is the equilibrium constant for the reaction of AH with water:

$$Ka = \frac{[A^-] \cdot [H_3O^+]}{[AH]}$$

Strong acids have large K_a values (i.e. the reaction equilibrium lies far to the right, lots of H_3O^+ present; the acid is almost completely dissociated). For example, the K_a value for hydrochloric acid (HCl) is 10^7.

Weak acids have small K_a values (i.e. at equilibrium significant amounts of AH and A^- exist together in solution; modest levels of H_3O^+ are present; the acid is only partially dissociated). For example, the K_a value for acetic acid is 1.8×10^{-5}.

Strong acids include the hydrohalic acids - HCl, HBr, and HI. (However, hydrofluoric acid, HF, is relatively weak.) Oxyacids, which tend to contain central atoms in high oxidation states surrounded by oxygen, are also quite strong and include HNO_3, H_2SO_4, $HClO_4$. Most organic acids are weak acids.

A few clarifications:

- The terms "hydrogen ion" and "proton" are used interchangeble- both refer to H^+.
- In chemical equations H^+ is often written, although in water it will actually be H_3O^+.
- The strength of an acid is measured by its K_a value. pH measures how many hydrogen ions are present, which depends on both the *type* of acid (or base) and *how much* is there.
- Acid strength is also defined by $pK_a = -\log(K_a)$.

Characteristics

Acids are generally:

- **Taste**: sour when dissolved in water
- **Touch**: strong acids have a stinging feeling
- **Reactivity**: acids react aggresively with many metals
- **Electrical conductivity**: acids are electrolytes

Different definitions of acid/base

The word acid comes from the Latin *acidus* meaning sour. In chemistry the term acid has a more specific meaning.

The Swedish chemist Svante Arrhenius defined an acid to be a substance that gives up hydrogen ions (H^+) when dissolved in water, while bases are substances that give up hydroxide ions (OH^-). This definition limits acids and bases to substances that can dissolve in water. Later on, Bronsted and Lowry defined an acid to be a proton donor and a base to be a proton acceptor. In this definition, even substances that are insoluble in water can be acids and bases. The most general definition of acids and bases is the Lewis definition, given by the American chemist Gilbert N. Lewis. Lewis theory defines a "Lewis acid" as an *electron-pair acceptor* and a "Lewis base" as an *electron-pair donor*. It can include acids that do not contain any hydrogen atoms, such as iron(III) chloride. Acid/base systems are different from redox reactions in that there is no change in oxidation state. The Lewis definition can also be explained with molecular orbital theory. In general an acid can receive an electron pair in its lowest unoccupied orbital (LUMO) from the highest occupied orbital (HOMO) of a base. That is, the HOMO from the base and the LUMO from the acid combine to a bonding molecular orbital.

The Bronsted-Lowry definition, where an acid is treated as a proton donor, is sufficient for many situations. In this case, the proton (H^+) is the actual acid and the acidity of the proton-donating-compound, such as an organic acid, is determined by its stability when it donates protons to the solution it is embedded in. So if the organic acid likes letting protons go, it has high acidity because it donates protons with empty molecular orbitals to the solution. This is how organic acids such as carboxylic acids work, here the Brønsted definition is nice for calculations while the Lewis definition is good for understanding.

Acid number

This is used to quantify the amount of acid present, for example in a sample of biodiesel. It is the quantity of base, expressed in milligrams of potassium hydroxide, that is required to neutralize the acidic constituents in 1 g of sample.

$AN = (V_{eq} - b_{eq}) \times N \times 56.1 / W_{oil}$.

V_{eq} is the amount of titrant (ml) consumed by the crude oil sample and 1ml spiking solution at the equivalent point, and b_{eq}beq is the amount of titrant (ml) consumed by 1ml spiking solution at the equivalent point.

The molarity concentration of titrant (N) is calculated as such: $N = 1000 \times W_{KHP} / (204.23 \times V_{eq})$.

In which, W_{KHP} is the amount (g) of KHP in 50ml of KHP standard solution, and Veq is the amount of titrant (ml) consumed by 50ml KHP standard solution at the equivalent point.

Acid number (mgKOH/g oil) for biodiesel is preferred to be lower than 3.

Neutralization

Neutralization is a type of reaction between an acid and a base. The products include a salt and water. So, it is also called a water forming reaction $acid + base \rightarrow water + salt$
Example: $HCl + NaOH \rightarrow H_2O + NaCl$

This type of reaction forms the basis of titration methods for analysing acids, where a pH indicator shows the point of neutralization.

Common acids

Strong inorganic acids

- Hydrobromic acid
- Hydrochloric acid
- Hydroiodic acid
- Nitric acid
- Sulfuric acid
- Chloric acid
- Perchloric acid

Weak inorganic acids

- Boric acid
- Carbonic acid
- Phosphoric acid

Weak organic acids

- Acetic acid
- Benzoic acid
- Butyric acid
- Citric acid
- Formic acid
- Lactic acid
- Malic acid
- Propionic acid
- Pyruvic acid
- Valeric acid

Acids in food

- **acetic acid** or **ethanoic acid**: (E260) found in vinegar and tomato sauce
- **adipic acid**: (E355)
- **alginic acid**: (E400)
- **benzoic acid**: (E210)
- **boric acid**: (E284)
- **ascorbic acid** (vitamin C): (E300) found in fruits
- **citric acid**: (E330) found in citrus fruits

- **carbonic acid**: (E290) found in carbonated beverages
- **carminic acid**: (E120)
- **cyclamic acid**: (E952)
- **erythorbic acid**: (E315)
- **erythorbin acid**: (E317)
- **formic acid**: (E236)
- **fumaric acid**: (E297)
- **gluconic acid**: (E574)
- **glutamic acid**: (E620)
- **guanylic acid**: (E626)
- **hydrochloric acid**: (E507)
- **inosinic acid**: (E630)
- **lactic acid**: (E270) found in dairy products such as yoghurt and sour milk
- **malic acid**: (E296)
- **metatartaric acid**: (E353)
- **nicotinic acid**: (E375)
- **oxalic acid**: found in spinach and rhubarb
- **pectic acid**: found in fruits and some vegetables
- **phosphoric acid**: (E338)
- **propionic acid**: (E280)
- **sorbic acid**: (E200) found in foods and drinks
- **stearic acid**: (E570)
- **succinic acid**: (E363)
- **sulfuric acid**: (E513)
- **tannic acid**: found in tea
- **tartaric acid**: (E334) found in grapes

Sources

- Listing of strengths of common acids and bases (*http://www.csudh.edu/oliver/chemdata/data-ka.htm*)
- Zumdahl, Chemistry, 4th Edition.

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